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LONG FREE VORTEX, MULTI-COMPARTMENT SEPARATION CHAMBER CYCLONE APPARATUS

This Application is of Continuation in Part Application to the Application No. 10/131425 dated ~~04/23/2002~~ 05/22/2002 W.T. when its Patent No. 6596170 will be issued on July 22, 2003 now abandoned.

This invention relates to an apparatus for continuous separation of solid-solid, solid-fluid suspension of particulate material. More specifically, the invention is directed to considerably increasing capacity and separation efficiency as well as to reduce pressure drop compared to the conventional conical cyclone separator.

BACKGROUND

An early hydrocyclone method and apparatus from U.S. Patent No. 453,105 (Bretney) issued May 28, 1891 in which there were two stages, in line, in the separating hydrocyclone. A frequent problem with this and later hydrocyclone devices are -- so called "back mix," high pressure drop and fast erosion of the conical portion.

A hydrocyclone is a device for creation of a free vortex, and it is the vortex that does the work in separating the particle matter form liquid.

The new features of the hydrocyclone air core as the vortex driving force, was discovered and used to greatly improve the

hydrocyclone collectors, Wlodzimierz J. Tuszko and all U.S. Patent No. 4,927,298 issued May 22, 1990. U.S. Patent No. 5,269,949 issued December 14, 1993, U.S. Patent No. 5,273,647 issued December 28, 1993, application Serial No. 08/238,903 filing date May 6, 1994 now abandoned. Application Serial No. 08/402,175 filing date March 10, 1955 now abandoned. U.S. Patent No. 6,071,424 issued June 6, 2000, Application 10/131425 filed ~~April 23, 2002~~ May 22, 2002 W.T.

It is the Patent No. 6071424 and Application Serial No. 10/131425 filed April 23, 2002 that generated the idea of multi-compartment separation chamber cyclone. This idea is absolutely unique from time when first Bretney's cyclone was patented. Thus, the idea of multi-compartment cyclone apparatus is obvious the intellectual property of the inventor of this Patent No. 6071424.

Therefore, the object of the present invention is to prevent the Patent No. 6071424 and Patent Application No. 10/131425 from infringement with claim elements omitted in these documents.

SUMMARY OF THE INVENTION

This invention relates to a device for separating of particulate fluid suspension known as a cyclone separator, in which centrifugal forces of the revolving particulate suspension cause separation of the suspension into finer and coarser or light and denser fractions. The conventional of the conical predominating

shape, cyclone features of both high pressure drop and energy consumption to get a low separation efficiency for low capacity. This conical cyclone portion participates in creating so-called "back mix" and is vulnerable to be fast eroded.

To avoid those harmful phenomenons the present invention provides long-free vortex multi-compartment separation chamber cyclone with air core or without it.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a view of the one compartment separation chamber conventional conical cyclone.

FIG. 2 is a cross-section view of FIG. 1.

FIG. 3 is a view of plurality of cylindrical telescopic unit to create multi-compartment separation chamber in cylindrical telescopic cylone housing as Embodiment1.

FIG. 4 is a view of plurality of cylindrical telescopic unit to create one compartment separation chamber in cylindrical telescopic cyclone housing as Embodiment2.

FIG. 5 is a view of plurality of cylindrical telescopic units to create multi-compartment separation chamber in conical cyclone housing as Embodiment3.

DETAILED DESCRIPTION OF THE INVENTION

A conventional conical cyclone for separating of fluid

mixtures which are centrifugally separable is illustrated in FIG.1 and FIG.2. This cyclone is comprised of short cyclindrical portion 1 having an inlet duct 2 for introduction of a feed suspension or feed mixture in tangential direction. An exhaust or overflow pipe 3 extends through the top or ceiling wall of the cylindrical portion 1. A frustum-conical portion 4 is axially aligned with the exhaust pipe 3. In the portion 1 and 4 together as in separating chamber the feed suspension of feed mixture flows in the helical swirling flow pattern so to establish counter-flowing outer 5 and inner 6 vortexes within the separating chamber inherently causing solids in the fluid flow, which are smaller or lighter to move to the inner vortex 6 and exist through overflow pipe 3 as a smaller or lighter product stream or overflow 7. Ingredients in the fluid flow which are coarser or heavier move to the outer vortex 5 and exit through the outlet 8 as a coarser or heavier product stream or as underflow 9. Along the central hydrocyclone vertical axis to the air core 10 is created, that extends from underflow outlet 8 throughout all long conical portion 4 cylindrical portion 1, and finally through the exhaust pipe 3.

The fundamental unit 16 of the new invented multi-compartment separation chamber comprises of two different diameter cylinders 12a and 12b axially connected with passage 13 that can be of the

same material as cyclone housing or is of replaceable liners. The plurality of those fundamental units when put together axially creates multi-compartment separation chamber, so that each compartment can be seen as a separate cyclone. This multi-compartment separation chamber can be designed in cylindrical telescopic cyclone housing or in another kind of housing; for example, in a conical one.

In Figure 3 is shown a plurality of cylindrical telescopic unit when multi-compartment separation chamber is designed in cylindrical telescopic cyclone housing as Embodiment1.

Further, the longitude axial wall section of fundamental unit is formed by two stretches -- upper one 15 and lower one 14. The upper stretch 15 creates with longitude cyclone axis the angle α. The lower stretch 14 creates with cyclone longitude axis the angle β. The inside angle between stretches 14 and 15 is the angle γ.

If a given dimensions of the two cylinders and the passage are as follows: H+h - total heights of upper cylinder

h - height of passage

D1 - diameter of upper cylinder

D2 - diameter of lower cylinder

$$tg\alpha_{max} = \frac{D_1 - D_2}{2(H+h)}$$

$$tg\beta_{max} = \frac{D_1 - D_2}{2h}$$

$$tg\alpha_{max} = tg\beta_{min}$$

then the angles α (β) whole change extent is

$0° \leq \alpha \leq \alpha_{max}$ $\beta_{max} \geq \beta \geq \beta_{min}$ $180° - \beta_{max} \leq \delta < 180°$

For situation of the angle Set No. 1 when and the unit consists of the predominanting upper cylindrical portion and of lower conical portion. Then, the best cyclone performances are to be achieved.

For situation of the angle Set No. 2 when $\alpha = \alpha_{max}$ and $\beta = \beta_{max}$ the unit is of one whole conical shape. Then, the worse cyclone performances are to be achieved.

For situation of the angle Set. No. 3, being between Set. No. 1 and Set No. 2 when $0° < \alpha < \alpha_{max}$ $\beta_{max} > \beta > \beta_{min}$. the unit consists of two conical portions upper one and lower one. The cyclone performances are gradually worsening after the angle α is growing.

In general case, the dimensions of all given multi-compartment separation chamber units can differ each other.

In FIG. 4 is shown Embodiment2 as particular case of Embodiment1. All units are of the same height dimensions and the same angle α_{max} is used for each unit. Then the multi-unit separation chamber of cylindrical telescopic housing becomes one conical compartment.

In FIG. 5 is shown the Embodiment3 when the multi-compartment separation chamber is designed as a replaceable liners put in conical housing.

The invention is not to be limited by the embodiment shown in the drawings or description in the specification which is given by way of example and not limitation, but only in accordance with scope of the appended claim.